CLAIMS

We claim:

1. A calibration standard for semiconductor metrology tools, the standard comprising:

a calibration substrate having a surface;

a calibration layer formed on the surface of the substrate to a thickness that is substantially similar to a desired target thickness; and

a protective layer formed over the calibration layer to prevent the deterioration of the underlying calibration layer.

2. The calibration standard of Claim 1 wherein the surface of the substrate has a root mean square (rms) surface roughness in the range of about 0.5 angstroms (Å) to about 1.0 Å; and

wherein the calibration layer formed on the surface of the substrate is formed having a thickness of in the range of about 5 Å to about 200 Å.

3. The calibration standard of Claim 2 wherein the calibration layer is formed using a material consisting of one of silicon dioxide, zirconium dioxide, hafnium dioxide, aluminum oxide, tantalum oxide, hafnium silicate, and zirconium silicate.

4. The calibration standard of Claim 2 wherein the calibration layer formed on the surface of the substrate is formed having a thickness tolerance of on the order of about 1% to about 2% of the desired target thickness.

5. The calibration standard of Claim 2 wherein the calibration layer formed on the surface of the substrate is formed having a thickness tolerance less than about 4% of the desired target thickness.

6. The calibration standard of Claim 2 wherein the calibration layer is formed having a thickness of in the range of about 5 Å to about 50 Å and having a thickness tolerance less than about 4% of the desired target thickness.

7. The calibration standard of Claim 2 wherein the protective layer is formed to a thickness of in the range of 500 Å to about 2000 Å having a thickness tolerance on the order of about 1% to about 2% of a desired thickness for the protective layer.

8. The calibration standard of Claim 2 wherein the calibration layer formed of silicon dioxide to a thickness of in the range of about 5-50 Å, having a thickness tolerance of less than about 4% of the desired target thickness.

9. The calibration standard of Claim 8 wherein the protective layer is formed of a amorphous silicon material to a thickness of in the range of 500 Å to about 2000 Å having a thickness tolerance on the order of about 1% to about 2% of a desired thickness for the protective layer.

10. The calibration standard of Claim 8 wherein the protective layer is formed of a material selected from the group of materials consisting of amorphous silicon, polysilicon, and silicon germanium (SiGe) material to a thickness of in the range of 500 Å to about 2000 Å having a thickness tolerance on the order of about 1% to about 2% of a desired thickness for the protective layer.

11. The calibration standard of Claim 8 wherein the protective layer is formed of a material consisting of one of HfO_2, ZrO_2, Ta_2O_5, Al_2O_3, $HfSiO_3$, and $ZrSiO_2$ having a thickness of in the range of 50 Å to about 100 Å thick and having a thickness tolerance on the order of about 1% to about 2% of the a desired thickness for the protective layer.

12. The calibration standard of Claim 1 wherein the desired target thickness of the calibration layer is the same thickness as a gate layer of an actual device to be measured; and

wherein the protective layer that is formed over the calibration layer is formed to a desired protective layer thickness that is of substantially the same thickness as a gate electrode overlying the gate layer of the actual device to be measured.

13. The calibration standard of Claim 12 wherein the calibration layer is formed having a thickness tolerance of about 4% of the desired target thickness for the calibration layer and

wherein the protective layer is formed having a thickness tolerance in the range of about 1% to about 2% of the desired thickness for the protective layer.

14. The calibration standard of Claim 13 wherein the calibration layer is formed having a thickness of about 1000 Å and wherein the protective layer is formed having a thickness in the range of about 5 Å to about 50 Å.

15. A method for forming a calibration standard for semiconductor metrology tools, the method comprising:

providing a substrate having a surface with a rms surface roughness of less than about 1.0 Å;

forming on the surface of the substrate a calibration layer having a thickness of about the same thickness as a layer to be measured; and

forming over the calibration layer a protective layer to protect the calibration layer from deterioration.

16. The method of Claim 15, wherein the method includes cleaning the surface of the substrate prior to forming the calibration layer.

17. The method of Claim 15, further including measuring the thickness of the calibration layer after it is formed and measuring the thickness of the calibration layer and the thickness of the protective layer after the protective layer is formed.

18. The method of Claim 15, wherein forming the calibration layer comprises forming the calibration layer having a thickness of in the range of about 5 Å to about 200 Å.

19. The method of Claim 18, wherein forming the calibration layer comprises forming the calibration layer having a thickness of in the range of about 5 Å to about 50 Å.

20. The method of Claim 19, wherein forming a calibration layer comprises forming the calibration layer to a thickness of in the range of about 5 Å to about 50 Å and having a thickness tolerance of less than about 4% of layer to be measured.

21. The method of Claim 18, wherein forming a calibration layer comprises forming the calibration layer using a material selected from among silicon dioxide,

zirconium dioxide, hafnium dioxide, aluminum oxide, tantalum oxide, hafnium silicate, and zirconium silicate.

22. The method of Claim 20, wherein forming a calibration layer comprises forming the calibration layer using a material selected from among silicon dioxide, zirconium dioxide, hafnium dioxide, aluminum oxide, tantalum oxide, hafnium silicate, and zirconium silicate.

23. The method of Claim 15, wherein forming the protective layer comprises forming the protective layer having a thickness of in the range of about 50 Å to about 1000 Å.

24. The method of Claim 23, wherein forming the protective layer comprises forming the protective layer of a material consisting of one of HfO_2, ZrO_2, Ta_2O_5, Al_2O_3, $HfSiO_3$, and $ZrSiO_2$ and having a thickness of in the range of 50 Å to about 100 Å thick and having a thickness tolerance of less than about 2% of a desired thickness for the protective layer.

25. The method of Claim 23, wherein the protective layer is formed having a thickness tolerance on the order of about 1% to about 2% of a desired thickness for the protective layer.

26. The method of Claim 23, wherein forming the protective layer comprises forming the protective layer of a material selected from among amorphous silicon, polysilicon, and SiGe and having a thickness of in the range of 50 Å to about 2000 Å

thick and having a thickness tolerance of about 4% of a desired thickness for the protective layer.

27. The method of Claim 26, wherein the protective layer is formed having a thickness tolerance in the range of about 1% to about 2% of a desired thickness for the protective layer.